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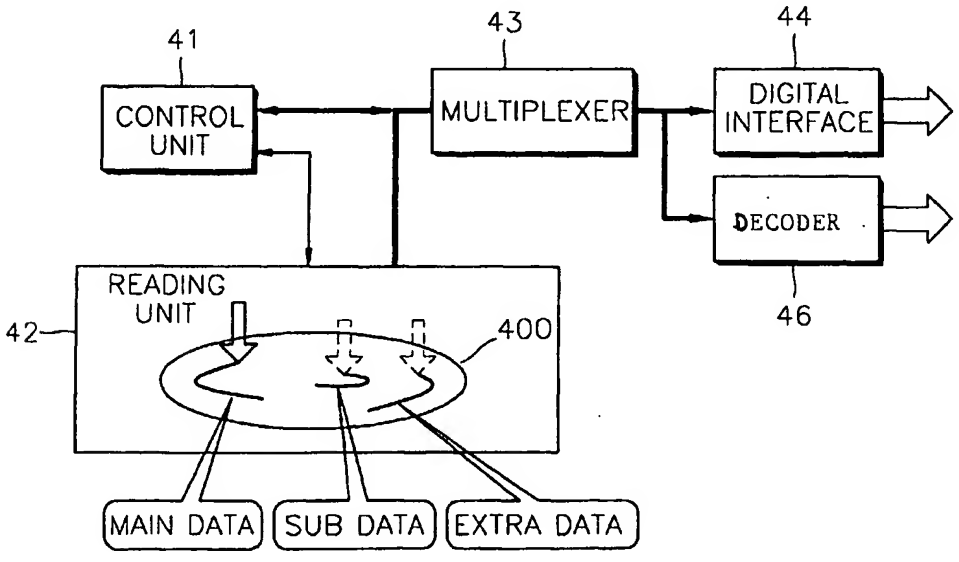
(54) Recording and reproducing multiple bitstreams in a data storage medium

(57) A data storage medium (400) in which multiple bitstreams are recorded, an apparatus and method for recording the multiple bitstreams, and an apparatus and method for reproducing the multiple bitstreams are provided. The reproducing apparatus includes: a reading unit (42) for reading main data including audio data and/or video data, and reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data; and a multiplexer (43) for multiplexing the main data and sub data read by the reading unit. Therefore, multiple bitstreams can be read and reproduced at the same time.

FIG. 4



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Description

[0001] The present invention relates to the field of recording and reproducing multiple bitstreams, and more particularly, to a data storage medium in which multiple bitstreams are recorded for multimedia data services, an apparatus and method for recording the multiple bitstreams, and an apparatus and method for reproducing the multiple bitstreams.

[0002] In conventional multi-media data storage media, different kinds of data such as video data, audio data, and/or extra data including text data are recorded in a multiplexed single bitstream. Recording apparatus for recording multimedia data record various kinds of data that constitute multimedia data in a single bitstream by multiplexing. Accordingly, apparatuses for reproducing multimedia data have only a function of reading and reproducing a single bitstream.

[0003] Therefore, when there is a need to replace a part of a bitstream recorded by multiplexing, first the multiplexed bitstream is read. Then, the part of the bitstream is replaced with new data, and the entire bitstream is recorded again. For example, when a user intends to replace an English caption recorded in a multimedia movie with a Japanese one, the bitstream of the movie is read and recorded again after replacing English caption data included in the bitstream with Japanese caption data. Furthermore, when the user wishes to restore the Japanese caption to the English caption, the English caption data, which was reserved for backup previously, is restored in the same process as for the Japanese caption replacement. In addition, when there is a need to insert a caption into a recorded movie, the bitstream of the movie is read, multiplexed together with caption data to insert the caption, and recorded again. These processes are relatively burdensome.

[0004] It is an aim of the present invention to provide a data storage medium in which various kinds of data constituting multimedia contents are recorded for easy editing and replacement with other data, and an apparatus and method for recording data in multiple bitstreams in a data storage medium.

[0005] According to a first aspect of the present invention, there is provided a data storage medium comprising: main data including audio data and/or video data; sub data recorded in a separate bitstream from the main data and reproduced in synchronization with the main data; and navigation information defining a relation required for the main data and the sub data to be output in synchronization with each other.

[0006] It is preferable that the data storage medium further comprises extra data recorded in a separate bitstream from the main data and the sub data and reproduced in association with the main data. In this case, the navigation information may further define a relation required for the main data and the extra data to be output in connection with each other.

[0007] It is preferable that the main data, the sub data and/or the extra data are input through a digital interface and recorded.

[0008] In a second aspect of the present invention, there is provided a recording method comprising: (a) recording main data including audio data and/or video data; (b) recording sub data to be reproduced in synchronization with the main data in a separate bitstream from the main data; and (c) recording navigation information defining a relation required for the main data and the sub data to be reproduced in synchronization with each other.

[0009] Preferably, the recording method further comprises: (d) recording extra data to be reproduced in connection with the main data in a separate bitstream from the main data and the sub data; and (e) recording navigation information defining a relation required for the main data and the extra data to be output in connection with each other.

[0010] It is preferable that step (a) comprises: (a1) receiving the main data through a digital interface; and (a2) recording the received main data.

[0011] It is preferable that step (b) comprises: (b1) receiving the sub data through the digital interface; and (b2) recording the received sub data.

[0012] It is preferable that step (c) comprises: (c1) receiving the extra data through the digital interface; and (c2) recording the received extra data.

[0013] In a third aspect of the present invention, there is provided a reproducing method comprising:(a) reading main data including audio data and/or video data; (b) reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data; and (c) multiplexing the read main data and the read sub data.

[0014] It is preferable that the reproducing method further comprises (d1) outputting the multiplexed main data and sub data through a digital interface, or (d2) decoding the multiplexed main data and sub data.

[0015] In the reproducing method, it is preferable that step (c) comprises: (c1) reading navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other; and (c2) multiplexing the read main data and the read sub data based upon the navigation information.

[0016] Alternatively, another reproducing method according to the present invention comprises: (a) reading main data including audio data and/or video data; (b) reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data; (c) reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and (d) multiplexing the read main data, the read sub data, and the read extra data.

[0017] In this embodiment, the reproducing method preferably further comprises (e1) outputting the multiplexed main data, sub data, and extra data through a digital interface, or (e2) decoding the multiplexed main

data, sub data, and extra data.

[0018] In the reproducing method above, it is preferable that step (d) comprises: (d1) reading navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other and for the read main data and extra data to be reproduced in connection with each other; and (d2) multiplexing the read main data, the read sub data, and the read extra data based upon the navigation information.

[0019] Another embodiment of the reproducing method according to the present invention comprises: (a) reading sub data recorded in a separate bitstream from main data including audio data and/or video data, which is later reproduced in synchronization with the main data; (b) reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and (c) multiplexing the read sub data and the read extra data.

[0020] In this embodiment, it is preferable that the reproducing method further comprises (d1) outputting the multiplexed sub data and extra data through a digital interface, or (d2) decoding the multiplexed sub data and extra data.

[0021] In the reproducing method above, it is preferable that step (c) comprises: (c1) reading navigation information defining a relation required for the read sub data and extra data to be reproduced in connection with each other; and (c2) multiplexing the read sub data and the extra data based upon the navigation information.

[0022] A fourth aspect of the present invention provides a recording apparatus comprising: a recording unit for recording main data including audio data and/or video data, recording sub data to be reproduced in synchronization with the main data in a separate bitstream from the main data, and recording navigation information defining a relation required for the main data and the sub data to be reproduced in synchronization with each other; and a control unit for generating the navigation information and providing the generated navigation information to the recording unit.

[0023] It is preferable that the recording unit further records extra data to be reproduced in connection with the main data in a separate bitstream from the main data and the sub data, and records navigation information defining a relation required for the main data and the extra data to be reproduced in connection with each other. In this case, the control unit preferably generates the navigation information defining the relation between the main data and the extra data and provides the generated navigation data to the recording unit.

[0024] It is preferable that the recording apparatus further comprises a digital interface for receiving the main data and/or the sub data, and the digital interface receives the extra data, and the recording unit records the received extra data and navigation information on the extra data.

[0025] It is preferable that the recording apparatus further comprises an encoder for receiving and encoding the main data and/or the sub data.

[0026] A fifth aspect of the present invention provides a reproducing apparatus comprising: a reading unit for reading main data including audio data and/or video data and reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data; and a multiplexer for multiplexing the main data and sub data read by the reading unit.

[0027] It is preferable that the reproducing apparatus further comprises a digital interface for outputting the multiplexed main data and sub data, or a decoder for decoding the multiplexed main data and sub data.

[0028] In the reproducing apparatus, it is preferable that the reading unit reads navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other, and the multiplexer multiplexes the read main data and the read sub data based upon the navigation information.

[0029] Also according to the present invention, there is provided a reproducing apparatus comprising: a reading unit for reading main data including audio data and/or video data, reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data, and reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and a multiplexer for multiplexing the main data, sub data, and extra data read by the reading unit.

[0030] It is preferable that the reproducing apparatus above further comprises a digital interface for outputting the multiplexed main data, sub data, and extra data, or a decoder for decoding the multiplexed main data, sub data, and main data.

[0031] In the reproducing apparatus above, it is preferable that the reading unit reads navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other and required for the read main data and extra data to be reproduced in connection with each other, and the multiplexer multiplexes the read main data, the read sub data, and the read extra data based upon the navigation information.

[0032] Another reproducing apparatus according to the present invention comprises: a reading unit for reading sub data recorded in a separate bitstream from main data including audio data and/or video data, which is later reproduced in synchronization with the main data, and reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and a multiplexer for multiplexing the sub data and extra data read by the reading unit.

[0033] It is preferable that the reproducing apparatus

above further comprises a digital interface for outputting the multiplexed sub data and extra data, or a decoder for decoding the multiplexed sub data and extra data.

[0034] In the reproducing apparatus above, it is preferable that the reading unit reads navigation information defining a relation required for the sub data and the extra data to be reproduced in connection with each other, and the multiplexer multiplexes the read sub data and the read extra data based upon the navigation information.

[0035] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 shows an example of data recorded on an optical disc according to a preferred embodiment of the present invention;

Figure 2 shows the structure of navigation information showing the relation between main data, sub data, and extra data of Figure 1;

Figure 3 is a block diagram of a recording apparatus according to a preferred embodiment of the present invention;

Figure 4 is a block diagram of a reproducing apparatus according to a preferred embodiment of the present invention;

Figure 5 is a block diagram of a recording and reproducing apparatus according to a preferred embodiment of the present invention;

Figure 6 is a flowchart illustrating a preferred embodiment of a recording method according to the present invention;

Figure 7 is a flowchart illustrating another preferred embodiment of the recording method according to the present invention;

Figure 8 is a flowchart illustrating a preferred embodiment of the reproducing method according to the present invention;

Figure 9 is a flowchart illustrating another preferred embodiment of the reproducing method according to the present invention; and

Figure 10 is a flowchart illustrating still another preferred embodiment of the reproducing method according to the present invention.

[0036] An example of data recorded in an optical disc according to a preferred embodiment of the present invention is shown in Figure 1. Referring to Figure 1, main data, sub data, and extra data are recorded in an optical disc in separate bitstreams. Here, the main data have corresponding sub data and extra data. However, not all the main data have corresponding sub data and/or corresponding extra data.

[0037] Main data refer to data that can be independently reproduced. For example, a movie including both video data and audio data may be a kind of main data. Sub data refers to additional data to main data, which contains components to be reproduced in synchronization with the main data. For example, sub-picture data to be reproduced as caption data along with video data recorded in a digital versatile disc may be a kind of sub data. Extra data refers to additional data associated with main data, including an Internet link with respect to a particular scene of a movie, a movie script, an actor's profile, and a bonus clip. Extra data are, but not necessarily, reproduced in synchronization with main data.

[0038] Sub data and/or extra data corresponding to main data can be recorded along with the main data at the same time or sequentially with a time gap. When the sub data and/or extra data and main data are recorded at the same time, a recording unit of an optical pickup alternately records the main data and corresponding sub data and/or extra data.

[0039] Although sub data and/or extra data are generally reproduced in synchronization with main data, the sub data and/or extra data may be recorded separately from corresponding main data. For example, only a sound track recorded as sub data of a movie, or only a movie script recorded as extra data of the movie may be output.

[0040] Figure 2 shows the structure of navigation information showing the relation between the main data, sub data, and extra data of Figure 1. Navigation information refers to control information required for easy searching and controlling multimedia contents stored in storage media including digital versatile discs (DVDs).

[0041] Referring to Figure 2, main data are associated with at least one sub data and/or extra data. The main data on the top of the structural diagram of Figure 2 have one sub data and one extra data as additional data, next main data have only sub data as additional data, and next main data have only extra data as additional data.

[0042] In particular, navigation information includes identifiers for particular bitstreams and playback time information on additional data corresponding to main data.

[0043] Figure 3 is a block diagram of a preferred embodiment of a recording apparatus according to the present invention. The recording apparatus according to the present invention may be an apparatus used by a manufacturer in the production of an optical disc such as DVDs, or an apparatus used by general users to record desired multimedia contents.

[0044] Referring to Figure 3, the recording apparatus includes a control unit 31, a recording unit 32, a digital

interface 34, and an encoder 35. Here, the digital interface 34 is for receiving external digital signals, for example, for receiving multimedia data including main data (and additional data), through a network. The encoder 35 receives and encodes main data or additional data, and transmits the coded main data or additional data to the recording unit 32. The recording apparatus may include only the digital interface 34 or the encoder 35 if necessary.

[0045] The recording unit 32 records the main data input from the digital interface 34 or the encoder 35 and additional data including sub data and/or extra data in separate bitstreams in an optical disc 300.

[0046] The control unit 31 generates navigation information defining the relation between the main data, the sub data and/or extra data and transmits the navigation information to the recording unit 32. The recording unit 32 also records the navigation information in a predetermined area of the optical disc 300. In a recording operation, the recording unit 32 radiates a laser beam onto the optical disc 300 through an optical pickup (not shown) based upon the control signal from the control unit 32.

[0047] In particular, all data are recorded to form a contiguous data area (CDA) to ensure normal reading and reproduction by a reproducing apparatus. In other words, data are recorded to ensure that a decoder can continuously supply data even when data reading is temporarily interrupted by movement of an optical head of an optical pickup in the reproducing apparatus.

[0048] Figure 4 is a block diagram of a preferred embodiment of a reproducing apparatus according to the present invention. The reproducing apparatus may be an apparatus used by general users to reproduce desired multimedia contents. Referring to Figure 4, the reproducing apparatus includes a control unit 41, a reading unit 42, a multiplexer 43, a digital interface 44, and a decoder 46. Here, the digital interface 44 is for externally transferring a digital signal, for example, transferring multimedia data including main data (and additional data) through a network. The decoder 46 decodes main data and/or additional data, which have been encoded and written, and read by the reading unit 42, and outputs the decoded main data or additional data to an output device, such as speakers or monitors (not shown). The reproducing apparatus may include only the digital interface 44 or the decoder 46 if necessary.

[0049] The reading unit 42 reads data recorded in an optical disc 400 by radiating a laser beam onto the optical disc 400 through an optical pickup based upon the control signal from the controller 42 and by converting the laser beam reflected from the optical disc 300 to an electrical signal. The reading unit 42 simultaneously reads the main data and the additional data including the sub data and/or extra data and transmits the read data to the multiplexer 43. The read bitstreams may be a combination of main data, sub data, and extra data, a combination of main data and sub data, and a combination of main data and extra data, a combination of sub data and extra data, etc. When at least two bitstreams are simultaneously read, an optical pickup of the reading unit 42 alternately reads the multiple bitstreams. The reading unit 42 has a buffering function so that it can continuously supply data to the decoder 46 even when data reading is temporarily interrupted in a reproducing operation by movement of an optical head of the optical pick.

[0050] The multiplexer 43 multiplexes the main data, the sub data, and/or the extra data, which have been separately received, based upon the navigation information. The multiplexer 43 can replace one component of main data with separate sub data and/or extra data. For example, if main data is a video title in which video data, audio data and/or extra data are multiplexed, the audio data and/or caption data can be replaced with corresponding sub data. A multiplexed bitstream output from the multiplexer 43 is externally transferred through the digital interface 44 or is decoded by the decoder 46.

[0051] Figure 5 is a block diagram of a preferred embodiment of a recording and reproducing apparatus according to the present invention. The recording and reproducing apparatus may be an apparatus used by general users to record or reproduce desired multimedia contents.

[0052] Referring to Figure 5, the recording and reproducing apparatus includes a controller 51, a recording/reading unit 52, a multiplexer 53, a digital interface 54, an encoder 55, and a decoder 56. Here, the digital interface 54 is for externally receiving or transferring a digital signal, for example, receiving or transferring multimedia data including main data (and additional data) through a network. The encoder 55 receives and encodes main data or additional data, and transmits the coded main data or additional data to the recording/reading unit 52. The recording and reproducing apparatus may include only the digital interface 54 or only the encoder 55 and the decoder 56 if necessary.

[0053] Here, the multiplexer 53, the encoder 55, and the decoder 56 have the same functions as those of the recording apparatuses and the reproducing apparatuses described above with reference to Figures 3 and 4. The recording/reading unit 52 has the functions of both the recording unit 32 of the recording apparatus described with reference to Figure 3 and the reading unit 42 of the reproducing apparatus described with reference to Figure 4. Also, the control unit 51 has the functions of both the control unit 31 of the recording apparatus and the control unit 41 of the reproducing apparatus. Therefore, explanations of the functions described above will not be repeated here.

[0054] Preferred embodiments of the recording and reproducing methods according to the present invention used by the recording and reproducing apparatuses which have the structures described above, will now be described.

[0055] Figure 6 is a flowchart illustrating a preferred

embodiment of a recording method according to the present invention. Referring to Figure 6, when main data are input from the digital interface 34 or the encoder 35 of the recording apparatus, the recording unit 32 records the main data in the optical disc 300 (step 601). Next, sub data to be reproduced in synchronization with the main data are recorded in an area separated from the area where the main data have been recorded (step 602). Navigation information defining the relation between the main data and the sub data are recorded in the optical disc 300 (step 603). Here, the main data and the sub data can be recorded simultaneously by alternation or in a predetermined sequential order.

[0056] Figure 7 is a flowchart illustrating another embodiment of the recording method according to the present invention. Referring to Figure 7, when main data are input from the digital interface 34 or the encoder 35 of the recording apparatus, the recording unit 32 records the main data (step 701). Next, sub data to be reproduced in synchronization with the main data are recorded in an area separated from the area where the main data have been recorded (step 702). Extra data are recorded in an area separated from the areas where the main data and the sub data have been recorded (step 703). Navigation information defining the relation between the main data, the sub data, and the extra data are recorded (step 704). Here, the main data, the sub data, and the extra data can be recorded simultaneously by alternation or in a predetermined sequential order.

[0057] Figure 8 is a flowchart illustrating a preferred embodiment of a reproducing method according to the present invention. Referring to Figure 8, the reading unit 42 of the reproducing apparatus or the recording/reading unit 52 of the recording and reproducing apparatus reads main data from the optical disc 400 or 500 (step 801). Next, sub data are read from an area separated from the area where the main data are recorded (step 802). The multiplexer 43 or 53 multiplexes the read main data and sub data (step 803). Here, necessary navigation information is read by the reading unit 42 or the recording/reading unit 52, and transmitted to the control unit 41 or 51, and then to the multiplexers 42 or 53 after being analyzed by the control unit 41 or 51. Alternatively, the navigation information read by the reading unit 42 or the recording/reading unit 52 can be transmitted directly to the multiplexer 43 or 53.

[0058] The multiplexed main data and sub data are output through the digital interface 44 or 54 (step 804), or are transmitted to and decoded by the decoder 46 or 56 (step 805). The decoded main data and sub data are transmitted to and reproduced through an output device such as a speaker, a monitor, or a printer.

[0059] Figure 9 is a flowchart illustrating another embodiment of the reproducing method according to the present invention. Referring to Figure 9, the reading unit 42 of the reproducing apparatus or the recording/reading unit 52 of the recording and reproducing apparatus reads main data from the optical disc 400 or 500 (step 901). Next, sub data are read from an area separated from the area where the main data are recorded (step 902). Extra data are read from an area separated from the areas where the main data and the sub data are recorded (step 903). The multiplexer 43 or 53 multiplexes the read main data, sub data, and extra data (step 904). Here, necessary navigation information is read by the reading unit 42 or the recording/reading unit 52, and transmitted to the control unit 41 or 51, and then to the multiplexers 42 or 53 after being analyzed by the control unit 41 or 51. Alternatively, the navigation information read by the reading unit 42 or the recording/reading unit 52 can be transmitted directly to the multiplexer 43 or 53.

[0060] The multiplexed main data, sub data, and extra data are output through the digital interface 44 or 54 (step 905), or are transmitted to and decoded by the decoder 46 or 56 (step 906). The decoded main data, sub data, and extra data are transmitted to and reproduced through an output device such as a speaker, a monitor, or a printer.

[0061] Figure 10 is a flowchart illustrating still another embodiment of the reproducing method according to the present invention. Referring to Figure 10, the reading unit 42 of the reproducing apparatus or the recording/reading unit 52 of the recording and reproducing apparatus reads sub data from the optical disc 400 or 500 (step 1001). Next, extra data are read from an area separated from the area where the sub data are recorded (step 1002). The multiplexer 43 or 53 multiplexes the read sub data and extra data (step 1003). Here, necessary navigation information is read by the reading unit 42 or the recording/reading unit 52, and transmitted to the control unit 41 or 51, and then to the multiplexers 42 or 53 after being analyzed by the control unit 41 or 51. Alternatively, the navigation information read by the reading unit 42 or the recording/reading unit 52 can be transmitted directly to the multiplexer 43 or 53.

[0062] The multiplexed sub data and extra data are output through the digital interface 44 or 54 (step 1004), or are transmitted to and decoded by the decoder 46 or 56 (step 1005). The decoded sub data and extra data are transmitted to and reproduced through an output device such as a speaker, a monitor, or a printer.

[0063] As described above, the present invention provides a data storage medium in which different kinds of data constituting multimedia contents are recorded in discrete bitstreams for easy data editing or replacement, and a recording apparatus and method for the same. The present invention also provides an apparatus and method for simultaneously reading and reproducing multiple bitstreams.

[0064] It is expected that there will be more types of multimedia data services in the future to satisfy a variety of needs of users. A variety of multimedia contents will be provided by multimedia service providers through networks. The present invention enables users to receive a variety of multimedia contents from multimedia service providers and to create a new multimedia con-

tent by data replacement or editing if necessary.

[0065] While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention as defined by the appended claims.

[0066] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0067] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0068] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0069] The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A data storage medium comprising:

   main data including audio data and/or video data;

   sub data recorded in a separate bitstream from the main data and reproduced in synchronization with the main data; and

   navigation information defining a relation required for the main data and the sub data to be output in synchronization with each other.

2. The data storage medium of claim 1, further comprising extra data recorded in a separate bitstream from the main data and the sub data and reproduced in connection with the main data, wherein the navigation information further defines a relation required for the main data and the extra data to be output in connection with each other.

3. The data storage medium of claim 1 or 2, wherein main data and/or sub data and/or extra data are received and encoded by an internal encoder (35) or are input through a digital interface (34) and recorded.

4. A recording method comprising:

   (a) recording main data including audio data and/or video data;

   (b) recording sub data to be reproduced in synchronization with the main data in a separate bitstream from the main data; and

   (c) recording navigation information defining a relation required for the main data and the sub data to be reproduced in synchronization with each other.

5. The recording method of claim 4, further comprising:

   (d) recording extra data to be reproduced in connection with the main data in a separate bitstream from the main data and the sub data; and

   (e) recording navigation information defining a relation required for the main data and the extra data to be output in connection with each other.

6. The recording method of claim 5, wherein step (a) comprises:

   (a1) receiving the main data and/or the sub data and/or the extra data through a digital interface (34); and

   (a2) recording the received main data, sub data and/or extra data.

7. The recording method of claim 5 or 6, wherein step (a) comprises:

   (a1) receiving the main data and/or the sub data and/or the extra data as an analog signal;

   (a2) encoding the received main data and/or sub data and/or extra data; and

   (a3) recording the encoded main data and/or sub data and/or extra data.

8. A reproducing method comprising:

   (a) reading main data including audio data and/or video data;

(b) reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data; and

(c) multiplexing the read main data and the read sub data.

9. The reproducing method of claim 8, further comprising (d1) outputting the multiplexed main data and sub data through a digital interface (44).

10. The reproducing method of claim 8, further comprising (d2) decoding the multiplexed main data and sub data.

11. The reproducing method of claim 8, wherein step (c) comprises:

(c1) reading navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other; and

(c2) multiplexing the read main data and the read sub data based upon the navigation information.

12. The reproducing method of claim 8, comprising:

reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and

multiplexing the read main data, the read sub data, and the read extra data.

13. The reproducing method of claim 12, further comprising outputting the multiplexed main data, sub data, and extra data through a digital interface.

14. The reproducing method of claim 12, further comprising decoding the multiplexed main data, sub data, and extra data.

15. The reproducing method of claim 12, comprising:

reading navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other and for the read main data and extra data to be reproduced in connection with each other; and
multiplexing the read main data, the read sub data, and the read extra data based upon the navigation information.

16. A reproducing method comprising:

(a) reading sub data recorded in a separate bitstream from main data including audio data and/or video data, which is later reproduced in synchronization with the main data;

(b) reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and

(c) multiplexing the read sub data and the read extra data.

17. The reproducing method of claim 16, further comprising (d1) outputting the multiplexed sub data and extra data through a digital interface.

18. The reproducing method of claim 16, further comprising (d2) decoding the multiplexed sub data and extra data.

19. The reproducing method of claim 16, wherein step (c) comprises:

(c1) reading navigation information defining a relation required for the read sub data and extra data to be reproduced in connection with each other; and
(c2) multiplexing the read sub data and the extra data based upon the navigation information.

20. A recording apparatus comprising:

a recording unit (32) for recording main data including audio data and/or video data, recording sub data to be reproduced in synchronization with the main data in a separate bitstream from the main data, and recording navigation information defining a relation required for the main data and the sub data to be reproduced in synchronization with each other; and

a control unit (31) for generating the navigation information and providing the generated navigation information to the recording unit.

21. The recording apparatus of claim 20, wherein the recording unit (32) further records extra data to be reproduced in connection with the main data in a separate bitstream from the main data and the sub data, and records navigation information defining a relation required for the main data and the extra data to be reproduced in connection with each other, and

the control unit (31) generates the navigation information defining the relation between the main

data and the extra data and provides the generated navigation data to the recording unit.

22. The recording apparatus of claim 21, further comprising a digital interface (34) for receiving the main data and/or the sub data.

23. The recording apparatus of claim 22, wherein the digital interface (34) receives the extra data, and the recording unit (32) records the received extra data and navigation information on the extra data.

24. The recording apparatus of claim 20, further comprising an encoder (35) for receiving and encoding the main data and/or the sub data.

25. A reproducing apparatus comprising:

a reading unit (42) for reading main data including audio data and/or video data and reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data; and

a multiplexer (43) for multiplexing the main data and sub data read by the reading unit.

26. The reproducing apparatus of claim 25, further comprising a digital interface (44) for outputting the multiplexed main data and sub data.

27. The reproducing apparatus of claim 25, further comprising a decoder (46) for decoding the multiplexed main data and sub data.

28. The reproducing apparatus of claim 25, wherein the reading unit (42) reads navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other, and the multiplexer (43) multiplexes the read main data and the read sub data based upon the navigation information.

29. A reproducing apparatus comprising:

a reading unit (42) for reading main data including audio data and/or video data, reading sub data recorded in a separate bitstream from the main data, which is later reproduced in synchronization with the main data, and reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and

a multiplexer (43) for multiplexing the main data, sub data, and extra data read by the reading unit.

30. The reproducing apparatus of claim 29, further comprising a digital interface for outputting the multiplexed main data, sub data, and extra data.

31. The reproducing apparatus of claim 29, further comprising a decoder for decoding the multiplexed main data, sub data, and extra data.

32. The reproducing apparatus of claim 29, wherein the reading unit reads navigation information defining a relation required for the read main data and sub data to be reproduced in synchronization with each other and required for the read main data and extra data to be reproduced in connection with each other, and the multiplexer multiplexes the read main data, the read sub data, and the read extra data based upon the navigation information.

33. A reproducing apparatus comprising:

a reading unit (42) for reading sub data recorded in a separate bitstream from main data including audio data and/or video data, which is later reproduced in synchronization with the main data, and reading extra data recorded in a separate bitstream from the main data and the sub data, which is later reproduced in connection with the main data; and

a multiplexer (43) for multiplexing the sub data and extra data read by the reading unit.

34. The reproducing apparatus of claim 33, further comprising a digital interface for outputting the multiplexed sub data and extra data.

35. The reproducing apparatus of claim 33, further comprising a decoder for decoding the multiplexed sub data and extra data.

36. The reproducing apparatus of claim 33, wherein the reading unit reads navigation information defining a relation required for the sub data and the extra data to be reproduced in connection with each other, and the multiplexer multiplexes the read sub data and the read extra data based upon the navigation information.

FIG. 1

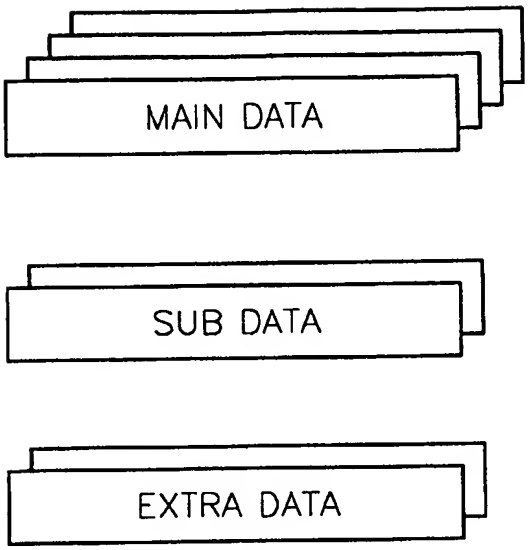


FIG. 2

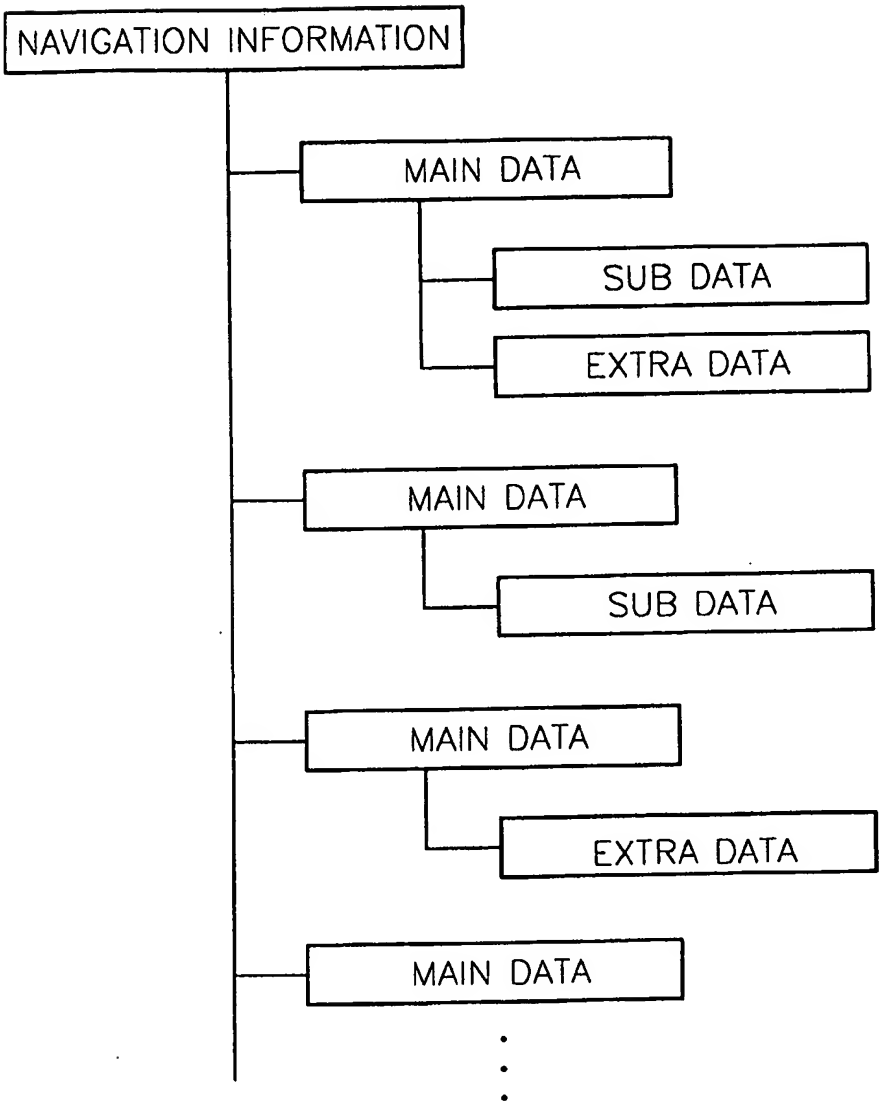

NAVIGATION INFORMATION
MAIN DATA
SUB DATA
EXTRA DATA
MAIN DATA
SUB DATA
MAIN DATA
EXTRA DATA
MAIN DATA

FIG. 3

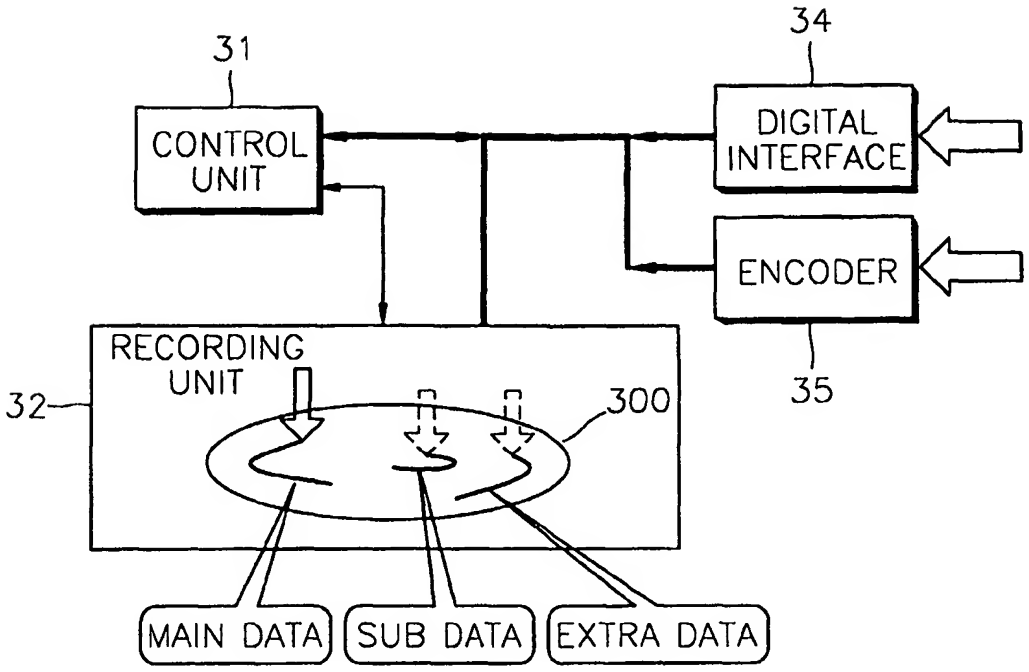

31
CONTROL UNIT
34
DIGITAL INTERFACE
ENCODER
35
RECORDING UNIT
32
300
MAIN DATA
SUB DATA
EXTRA DATA

FIG. 4

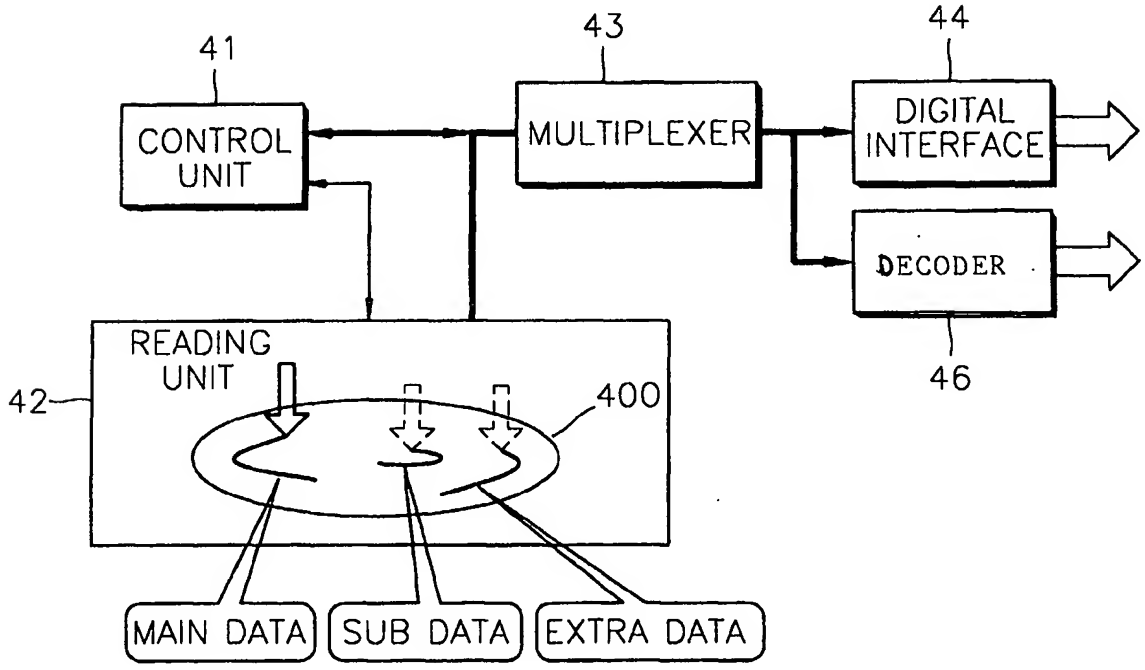

41
CONTROL UNIT
43
MULTIPLEXER
44
DIGITAL INTERFACE
DECODER
46
READING UNIT
42
400
MAIN DATA
SUB DATA
EXTRA DATA

FIG. 5

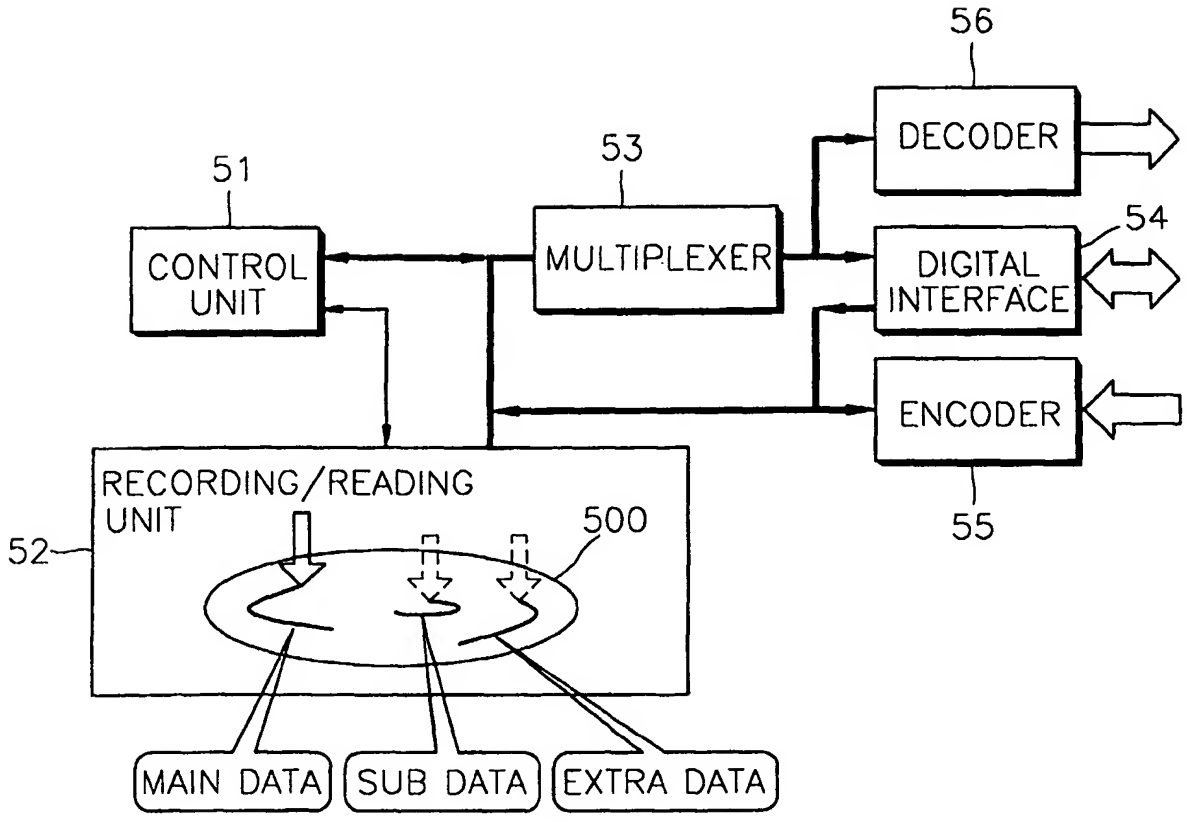

56
DECODER
53
51
MULTIPLEXER
54
CONTROL UNIT
DIGITAL INTERFACE
ENCODER
55
RECORDING/READING UNIT
500
52
MAIN DATA
SUB DATA
EXTRA DATA

FIG. 6

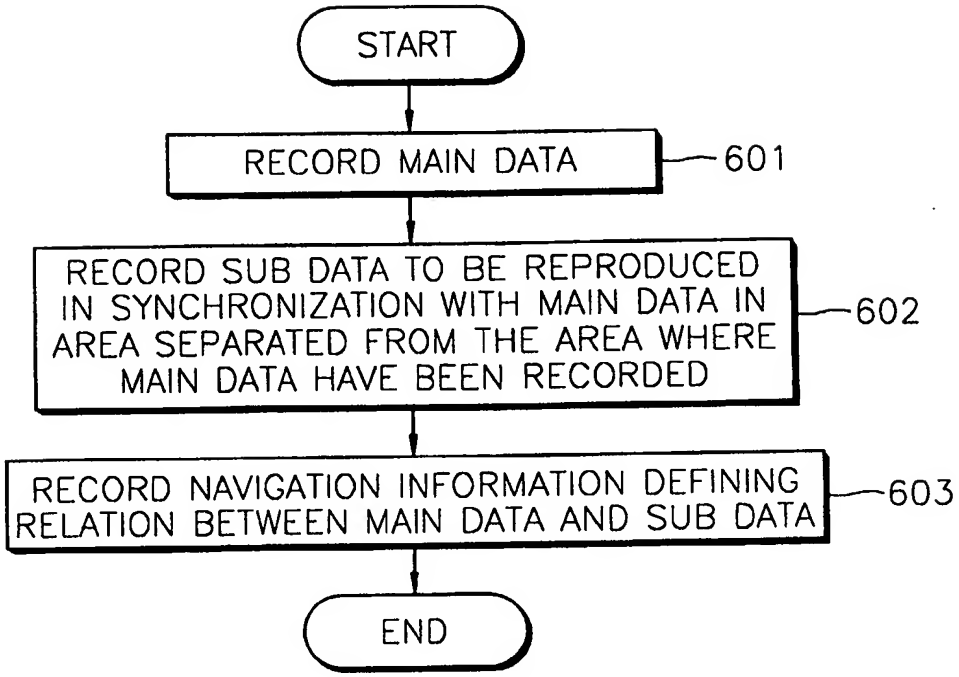

START
RECORD MAIN DATA
601
RECORD SUB DATA TO BE REPRODUCED IN SYNCHRONIZATION WITH MAIN DATA IN AREA SEPARATED FROM THE AREA WHERE MAIN DATA HAVE BEEN RECORDED
602
RECORD NAVIGATION INFORMATION DEFINING RELATION BETWEEN MAIN DATA AND SUB DATA
603
END

FIG. 7

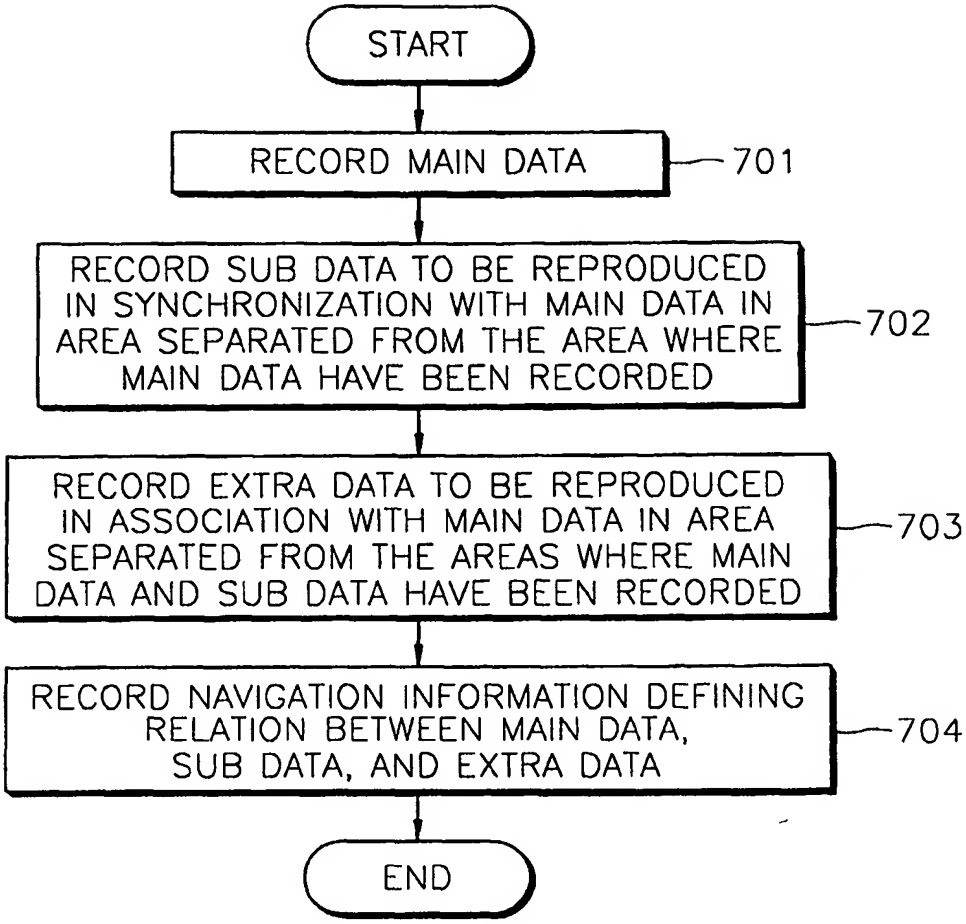

START
RECORD MAIN DATA
701
RECORD SUB DATA TO BE REPRODUCED IN SYNCHRONIZATION WITH MAIN DATA IN AREA SEPARATED FROM THE AREA WHERE MAIN DATA HAVE BEEN RECORDED
702
RECORD EXTRA DATA TO BE REPRODUCED IN ASSOCIATION WITH MAIN DATA IN AREA SEPARATED FROM THE AREAS WHERE MAIN DATA AND SUB DATA HAVE BEEN RECORDED
703
RECORD NAVIGATION INFORMATION DEFINING RELATION BETWEEN MAIN DATA, SUB DATA, AND EXTRA DATA
704
END

FIG. 8

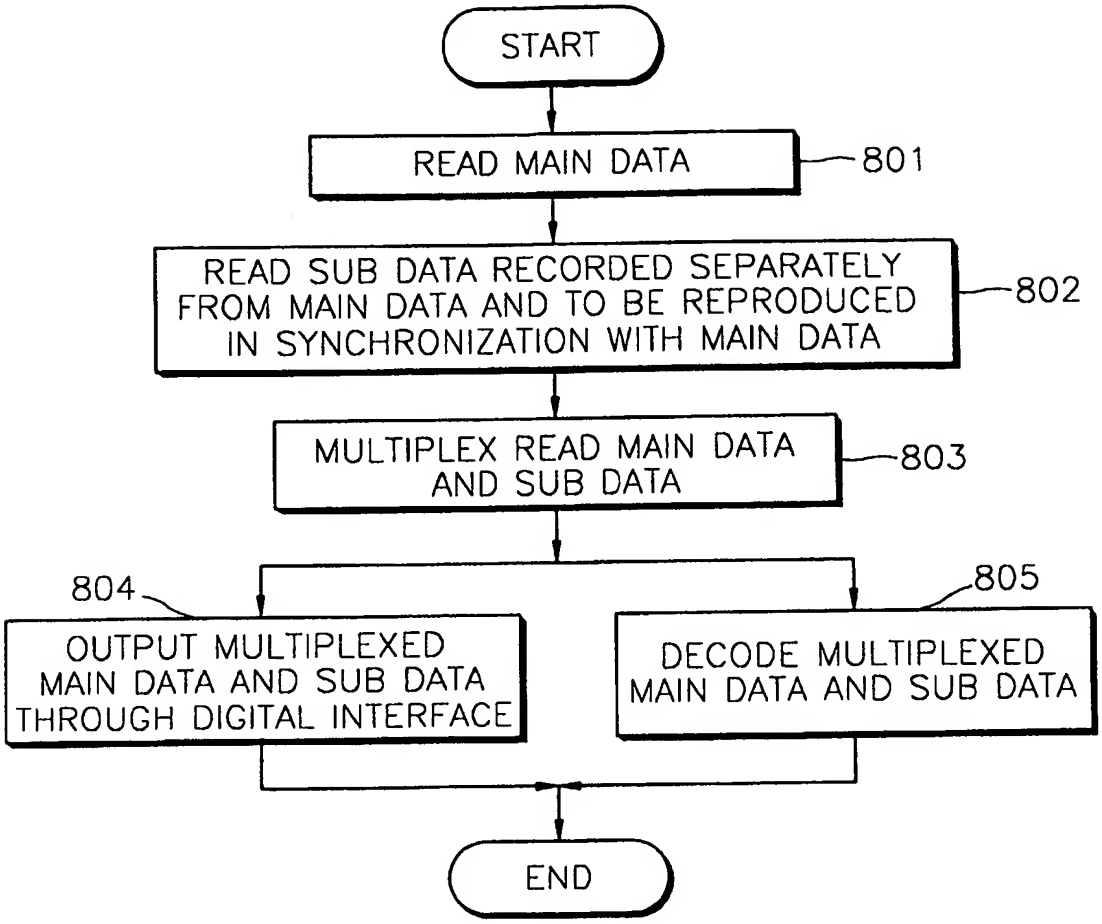

START
READ MAIN DATA
801
READ SUB DATA RECORDED SEPARATELY FROM MAIN DATA AND TO BE REPRODUCED IN SYNCHRONIZATION WITH MAIN DATA
802
MULTIPLEX READ MAIN DATA AND SUB DATA
803
804
OUTPUT MULTIPLEXED MAIN DATA AND SUB DATA THROUGH DIGITAL INTERFACE
805
DECODE MULTIPLEXED MAIN DATA AND SUB DATA
END

FIG. 9

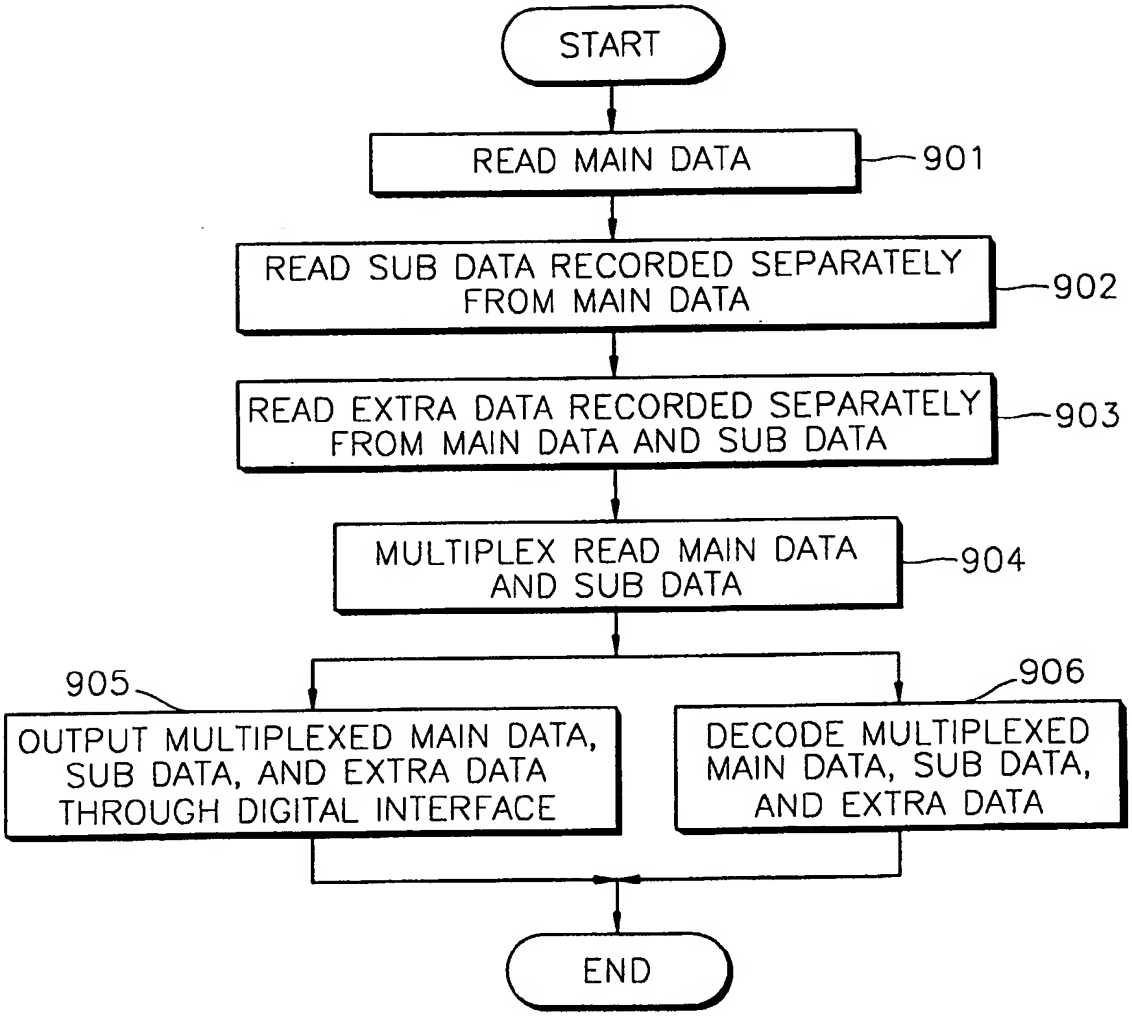
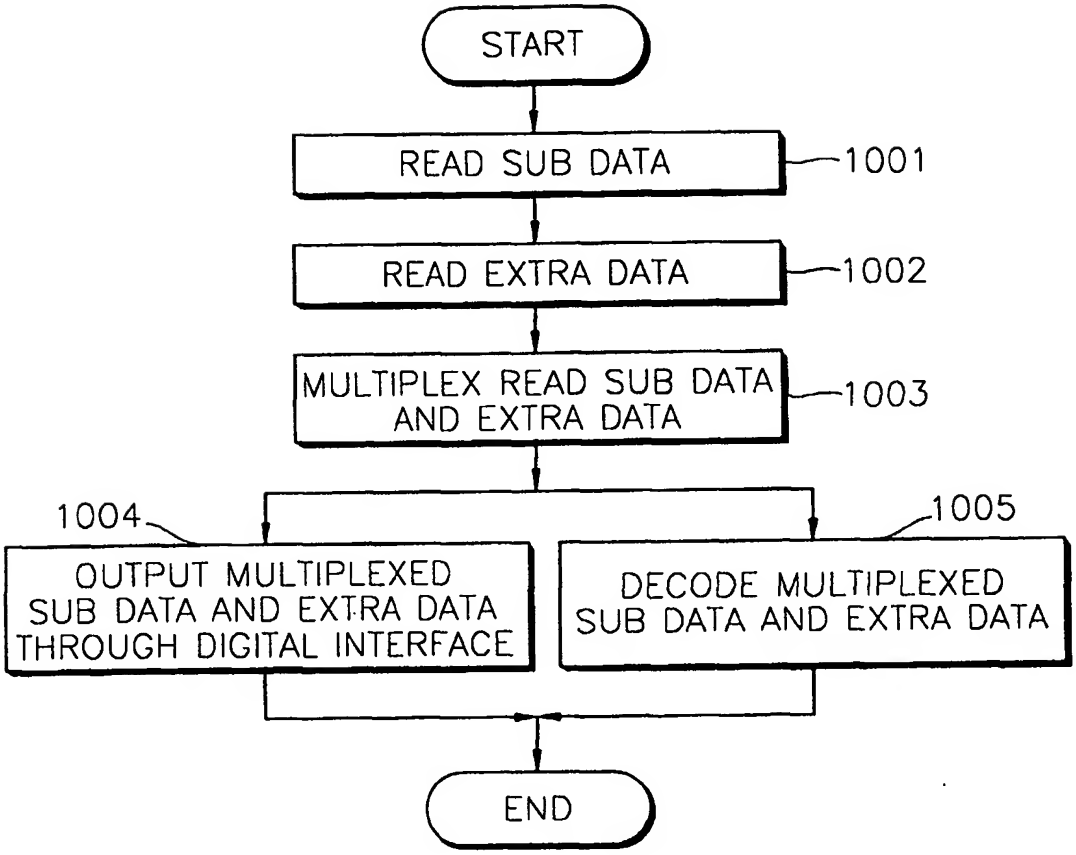

START
READ MAIN DATA
901
READ SUB DATA RECORDED SEPARATELY FROM MAIN DATA
902
READ EXTRA DATA RECORDED SEPARATELY FROM MAIN DATA AND SUB DATA
903
MULTIPLEX READ MAIN DATA AND SUB DATA
904
905
OUTPUT MULTIPLEXED MAIN DATA, SUB DATA, AND EXTRA DATA THROUGH DIGITAL INTERFACE
906
DECODE MULTIPLEXED MAIN DATA, SUB DATA, AND EXTRA DATA
END

FIG. 10


START
READ SUB DATA
1001
READ EXTRA DATA
1002
MULTIPLEX READ SUB DATA AND EXTRA DATA
1003
1004
OUTPUT MULTIPLEXED SUB DATA AND EXTRA DATA THROUGH DIGITAL INTERFACE
1005
DECODE MULTIPLEXED SUB DATA AND EXTRA DATA
END